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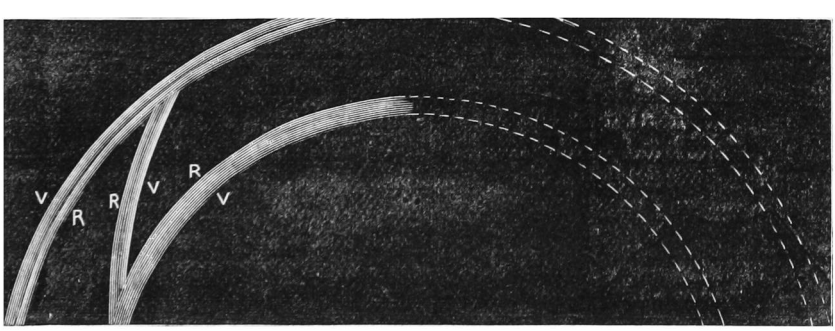
EXTRAORDINARY OR WATER-REFLECTION RAINBOW.

WE have been favoured by our esteemed correspondent, Dr. Clouston, with a description and sketch of a phenomenon, which has at present only the vague title Extraordinary Rainbow, but for which, unless a better term is proposed, we suggest that of Water-Reflection Rainbow. Dr. Clouston's note is as follows :—

On Nov. 29th, at 10.15 a.m., I observed a beautiful double iris, with an abnormal one having the same base as the primary one, and joining the secondary one about half way between its base and summit, lying across the space that separated them. It partook of the nature of a primary bow in the arrangement of its colours, having the red externally, but they were as faint as those of the secondary bow. It lasted for about 10 minutes after I observed it. This seems the place for curious rainbows; you will, perhaps, remember the one sketched by Dr. Mitchell here a few years ago. I send you a sketch of this, and will be glad if any of your correspondents can give an explanation.

CHARLES CLOUSTON.

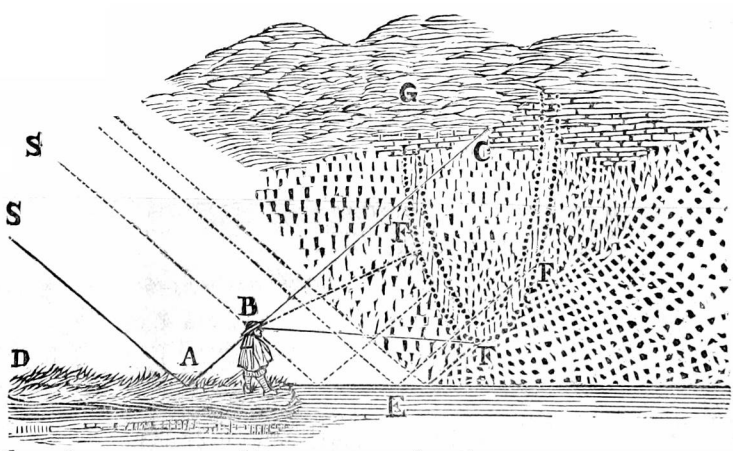
Sandwick Manse, Stromness, Orkney.



This phenomenon has been often described and explained, but, nevertheless, we believe that it is very little known, and that the majority of our readers would join Dr. Clouston in desiring an explanation. We could give this in two lines, and therewith allow the subject to drop; but as we happen to possess some rare notices of the phenomenon, we take the present opportunity of extracting and reprinting them for the benefit of our readers. The rainbow, or rather

portion of a bow, which Dr. Clouston saw, was produced by a reflected image of the sun in some body of nearly still water. The first reference which we possess to such a phenomenon is in the *Specimina Philosophiæ* of Renati Descartes. We reprint verbatim from the 4to Elzevir edition of 1677, and give the diagram in facsimile :—

"Atque ita nullam difficultatem in hac materia superesse arbitror ; nisi fortè circa illa, quæ præter ordinem assuetum naturæ in eâ contingunt. Ut quum arcus non accuratè rotundus est, aut centrum illius in rectâ lineâ Solem et oculum transeunte non jacet. Quod accidere potest vento guttarum figuram immutante : nunquam enim tam parum à sphæricâ suâ figurâ discedere possunt, quin statim illud notabilem differentiam in angulo, sub quo colores videri debent, efficiat. Audivi etiam aliquando arcum cœlestem inversum cornibus in altum erectis apparuisse, qualem hîc repræsentatum videmus F F. Quod vix crediderim accidisse, nisi per reflexionem radiorum solarium, incurrentium in superficiem maris aut lacus alicujus. Ut si à parte cœli S S effusi, caderent in aquam D A E, et indè ad pluviam C F resilirent, oculus B videret arcum F F, cujus centrum in puncto C ; ita ut prolatâ lineâ C B usque ad A, et A S transeunte per centrum Solis, anguli S A D, et B A E æquales sint, et angulus C B F duorum et quadraginta circiter graduum. Ad hoc tamen etiam requiritur summa aëris tranquillitas, ne vel minimus ventorum flatus, aquæ E superficiem inæqualem reddat ; et fortè insuper, ut nubes quædam isti aquæ superincumbat qualis G, quæ impediat ne lumen Solis rectà ad pluviam tendens, illud quod aqua eò reflectit, supprimat atque extinguat, unde sit ut non nisi rarissimè videatur. Oculus præterea in tali situ respectu Solis et pluviæ esse potest, ut videat partem inferiorem circuli, quo integra Iris constat, non videndo superiorem ; atque ita ut illum pro Iride inversâ sumamus, etiamsi tunc non versus cœlum, sed tantummodo versus terram aut aquam respicientibus appareat."

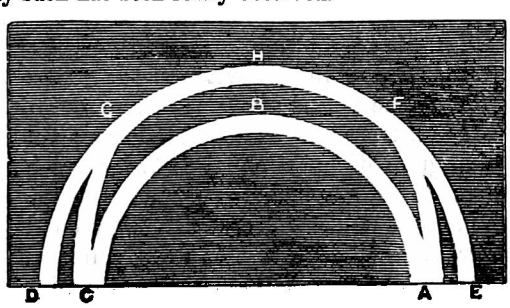


Although we can neither accept the diagram as representing a possible occurrence, nor all the reasoning of Descartes, there is no doubt that in attributing the extraordinary bow to reflection from a water surface, he gave another proof of his mental acumen.

In 1698 a water-reflection rainbow was seen by Halley, and the observation is thus reported in the *Phil. Trans.* :—

"August 6th, 1698. Between 6 and 7 o'clock in the evening, I observed an Iris, exceedingly vivid as to its colours, at first on the south side only, but in a little time with one entire arch ; and soon after, the beams of the sun being very strong, there appeared a secondary Iris, whose colours were more than ordinary

bright, but inverted, as usually, that is, the red was inwards, which in the primary Iris is outward, and *e contra* for the blues. But what I took most notice of was, that with these two concentric arches, there appeared a third arch, near upon as bright as the secondary Iris, but coloured in the order of the primary, which took its rise from the intersection of the horizon and primary Iris, and went across the space between the two, and intersected the secondary, as in the figure C G A F intersects the secondary Iris D G H F E, dividing the arch D E into three equal parts, as near as I could then guess. But at first the arch C G did not appear, which afterwards became as bright as the former. I observed the points G and F to arise, and the arch G F gradually to contract, till at length the two arches, G F and G H F, became coincident, when, for a great space, the secondary Iris lost its colours, and appeared like a white arch at the top. I observed, also, that at the points G and F, the intersection of the interior red of the secondary Iris, and the exterior red of the arch was much more intensely red than the outward limb of the primary Iris, and that during the whole appearance the upper part of the third Iris was not at all visible beyond the intersections G F. This uncommon sight entertained me for about twenty minutes, when the clouds blowing away the whole vanished. I was at first amazed with the sight, but afterwards, recollecting that the sun shone along the River Dee, which from thence empties itself into the W.N.W. where the sun then was, I concluded this secondary arch, C G H F A, was produced by the beams of the sun reflected from that water, which at that time was very calm; and it had been much more bright had it been at that time about high, as it was low water, when all the sands were bare. I was soon confirmed that my supposition was right, and that it answered all the appearance without any scruple, and that the arch C G H F A was no other than that part of the circle of the Iris, that would have been under the earth, bent upwards by reflection. I remember not to have read of any such Iris in any author. Descartes indeed speaks of an inverted Iris by reflection, but it is not possible to be seen as he describes it, and I query whether ever any such has been really observed."



On Nov. 14th, 1826, a similar bow was seen from the Soe House, near Belfast, by the Rev. Dr. Mant, M.R.I.A., Lord Bishop of Down and Connor, and fully described, with a coloured engraving, in the Trans. Roy. Irish Academy, vol. xv. The water surface in this case was probably Belfast Lough.

The following are more recent notices of the phenomena:—

"If the image of the sun is reflected by a surface of quiet water toward a cloud, this image may, in like manner, produce a rainbow, as in this case, two suns, one of which is as much below the horizon as the other is above, project their rays towards the cloud. The two bows will always meet, so that the angle between the refracted and the incident ray is 41°. The two bows will therefore cut each other, but the point of intersection depends on the height of the sun. Four bows are thus frequently seen, because the sun and also its reflected image each produces a second bow."—*Kaemtz's Meteorology*, by C. V. Walker; 1845, p. 443.

"Should circumstances be favourable, such as the presence of a sheet of water

whose surface reflects the sun's rays upon the cloud, then we shall have formed other rainbows, arising in the same manner as the primary and secondary arcs, the reflected beams being the exciting cause. These will intersect, in a point depending upon the sun's altitudes those produced directly. This phenomenon has been described as seen at Chartres on Aug. 10th, 1665, and from the walls of Chester, by Dr. Halley, Aug. 6, 1698."—*Introduction to Meteorology*, by D. P. Thomson, M.D.; 1849. p. 222.

"EXTRAORDINARY BOWS.—When the light of the sun is reflected from the surface of tranquil water, rainbows of singular form are at times observed. On the 6th of August, 1698, Dr. Halley beheld, while walking on the walls of Chester, by the river Dee, a rainbow of the form represented in fig. 24, where C B A is the primary bow, D H E the secondary, and C G H F A the extraordinary bow, cutting the secondary at G and F; its colours were arranged like those of the primary. The sun was shining clearly upon the calm surface of the river, and Dr. Halley discovered that the extraordinary bow was nothing more than the rest of the circle of which the primary was a part bent upwards by reflection from the water. A similar rainbow formed by reflection from the river Eure was beheld at Chartres, in 1665, where a faint arch was seen crossing the primary at its summit." —*Elements of Meteorology*, by J. Brocklesby, 1849, p. 175.

In treating of the Optical Phenomena of the Atmosphere, Professor Bravais has few, if any, equals. We are not aware that he has written any Memoir on Rainbows, analogous to his splendid work on Halos,* but in the *Annuaire Météorologique de la France*, pour 1849, p. 311, there is an interesting "Notice sur l'arc-en-ciel," from which we translate the portion bearing on our present subject:—

"One of the most remarkable varieties of rainbow is that produced by the reflected image of the sun. When a sheet of perfectly calm water reflects (répercute) the sun's rays, and directs them upon a cloud suitably situated for the production of a rainbow, it will form another arc of the first order, of 42° radius, whereof the centre will be as much below the horizon as the sun is above it. The culminating point of this reflection-arc will therefore be separated from the summit of the direct arc by an angular distance equal to twice the height of the sun above the horizon. If the sun be high, and the sheet of water extensive, it is evident that the reflection-arc may cut both the primary and secondary direct arcs. It was this form which Outhier saw, July 27th, 1736, during his voyage in Lapland, and which Celsius saw in 1743, the reflecting surface being in the first instance a lake, and in the second it was furnished by 'le Dala-Elf.' If the altitude of the sun be only a few degrees, the reflection arc lies between the primary and secondary bows, as in an observation by Senguerd, and in that of Wartmann, at Lausanne, in 1846. Halley, at Chester, saw the summit of the reflection-arc touch the secondary bow. Brandes cites other examples seen by Shulz, Sturges, Playfair, and others.

"If the sheet of reflecting water be small, the reflection arc ought to be very incomplete, and to present the appearance of a simple luminous fragment, more or less elevated above the two other arcs. This form was seen in Paris in April, 1847, and considering the position of the observers, I have no doubt that the fragment of an arc seen at an

* *Mémoire sur les Halos et les phénomènes optiques qui les accompagnent. Journal de l'Ecole Polytechnique Tome* xviii. Paris, 1847; 4to.

altitude of about 70°, was due to the reflection of the solar rays from the large basins near the Panthéon, which act as reservoirs for the water from the wells at Grenelle.

"If the sun be near the horizon, and the water surface slightly agitated, the reflection arc takes a remarkable form—its upper part disappears, and the lateral portions alone remain visible as vertical columns tangential to the right and left extremities of the ordinary bow; the reflection-arc is the exterior of a series of a series of first order arcs which have their centre in the sun's vertical; these arcs are almost superposed near the horizon, but separate nearer their culmination; and the diminution of light resulting from this separation of the several arcs prevents their visibility in that part of the sky.

"This is the form which Bowman saw soon after sunrise (B.A. Report, 1840). Playfair and Brandes have similarly only seen the lateral portions of reflection-arcs; they were tangents to the ordinary arc for 7° or 8°; the altitude of the sun was only 2°.

"A single occurrence cannot be explained in the foregoing manner—namely, the observation made by Canon Etienne, at Chartres, August 10th, 1665, with the sun at an altitude of 6° The centre of the extra ordinary arc was not in the solar vertical, and the arc appeared to be a portion of a great circle; it cut the ordinary arc obliquely near its point of culmination (*Journal des Savants*, 1666). I can render no perfectly satisfactory explanation of this very singular arrangement."

The reference to the subject in *Meteorologie*, von C. S. Cornelius, Halle, 1863, p. 503, is not very precise; freely translated it amounts to this:—

"It may be well here to mention that occasionally double, intersecting or even reversed (umgekehrte) rainbows have been observed. That is to say, as in the above described manner a bow may occur on a raincloud, so under certain circumstances it may happen that by the reflection of the sun's rays from a surface of still water, a second rainbow may be produced, having a different central point and in a certain manner intersecting the first bow; in other words, the image of the sun, which to a certain extent takes the place of another sun below the horizon, produces another bow differing from the first bow in position only."

"When the sun is reflected from the surface of still water, *extraordinary bows* are sometimes formed. From the reflected image of the sun being in effect beneath the horizon, such bows are larger than a semicircle. The arrangement of the colours is the same as the primary bow; and when their summit happens to coincide with that of the secondary bow, a band of white light is formed at the place of union, where they blend together."—*Handy Book of Meteorology*, by ... Buchan, 1868. p. 317.

"One of the most singular rainbows on record was that seen by Dr. Halley from the walls of Chester. C B A and D H E were the primary and secondary rainbows as seen under ordinary circumstances. Between these was another arch, C G H F A rising from the intersection of the horizon with the primary rainbow, and in its upper part dividing the secondary bow into three nearly equal parts. This intermediate arch was coloured in the same way as the primary rainbow; but during the progress of the phenomenon, Halley saw the points G F rise, and the ... F

gradually contract till the portions of the two bows between those points were identified. The intermediate and secondary bows having their colours contrary, produced, therefore, white between the points G and F ."—*Meteorology*, by G. Harvey, F.R.S., *Ency. Metrop.* London, 1848; 4to. p. *171.

Although there is some tautology in the shorter of the above notes, we think that a less evil than it would be to leave the collection imperfect, and slightly different details will be found in every one.

UNIFORMITY OF OBSERVATION HOURS.

To the Editor of the Meteorological Magazine.

SIR,—It is only now that I have remarked in your journal the review of the 9th and 10th volumes of the Meteorological Annals of our Central Institute.

I am sorry to find that you find fault with our publications because we did not lay enough stress on the uniformity of hours for observation.

I think you are aware of the fact that in Austria we have throughout unpaid volunteer observers. The difficulty of bringing them to adopt the same hours for observation is very great, almost insuperable for an Institute like ours, which has no controlling power (in the English sense of the word), but has to confine itself to entreaties which the observers are perfectly free to follow or not.* There are large climatic differences in our system of meteorological stations, and according to them, different ways of living among the various races which form the population of the Austrian Empire.

You know, perhaps, that after the recommendation of the Mannheim Society in the past century, and after the example set by Dove, the combinations 6^h 2^h 10^h had been recommended to the observers when the Vienna Central Institute was founded (23rd July, 1851).

But we found it impossible to induce observers in the southern provinces to adopt as early an hour as 6^h. In Carinthia we found an already existing system of meteorological stations carried on by the late Director J. Prettner, and employing the hours 7^h 2^h 9^h, recommended also by Humboldt as giving a very good mean daily temperature, by using the formula $\frac{1}{4}[(7) + 2(2) + (9)]$.

You know that there exists a great division in meteorological work between observations to be used for researches on the general laws of the atmospheric disturbances, or in a more general way, for International Meteorology, and those observations to be used for climatological studies.

For this latter branch of meteorology the Congress at Vienna did not exact uniformity of hours of observation. The men assembled at Vienna, knowing the difficulties inherent in any organization based

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* Of course I would prefer to have a staff of skilled and paid observers, and receive some £50,000 from the Government as General Myer does.

on unpaid volunteer action, thought it better to receive observations made at different hours than no observations at all. Then if we arrived for one country, Austria, at a uniformity of hours of observations, do you think the observers in England, France, and Italy would be induced to accept the same? and if not, do you think it a measure of first importance to establish uniform hours for Austria only, different from those in England, France, Italy, &c.?

We must advance gradually to the desired unity. For the moment I think we can be content to use the liberty left by the Vienna Congress, of choosing between different combinations. But may I, at the same time, draw your attention to the fact that the Congress has recommended that in every existing system of Meteorological Observations, researches should be made what corrections are to be applied to the daily means of the observations for obtaining *true means*, that is, according with means obtained by registering instruments, or taken every hour in 24. The Congress said further, "It is desirable to reduce the monthly means of temperature (as obtained by taking simply the sum and dividing it by the number of observations) to *true means*, and to *publish them likewise*."

Now, you find the corrections alluded to developed in a memoir published by the Academy of Vienna* and the table of corrections, corrected and enlarged, has been reprinted in the "Meteorological Annals of the Austrian Empire," vol. III., pp. 24—30.

Still more is done. Every volume of the Jahrbucher (and consequently also the Vol. IX. and X.), contains besides the plain means, the true means of temperature, or 24-hourly means. These are strictly comparable with any means obtained in England, France, and Italy, if in these countries as in Austria the pains were taken to reduce the plain means to 24-hourly, as the Meteorological Congress recommended.

As I value very highly your Magazine, and as I am desirous that a somewhat erroneous impression should not be left on the mind of the British Meteorological world, I should be obliged if you would have the kindness to publish these remarks on the Review (in Sept., 1875, p. 127), in your journal.—Yours truly,

DR. CH. JELINECK.

Hohe Warte bei Wien.

While we feel honoured by the above communication from one of the most able meteorologists of the present day, we are unable, in the slighest degree, to modify the opinions expressed in the Review. We admit all Dr. Jelineck's arguments, but our conviction that it is desirable that he should aim at greater uniformity remains unaltered,

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* "On the Diurnal Variations of Temperature, according to the Observations at the Stations in Austria. Memoirs of the Academy of Vienna."—Vol. XXVII.

and our experience with an unpaid staff of observers ten times as numerous as his, leads us to believe that he under estimates the control which he possesses over his observers, and over estimates the difficulty of reducing them to strict uniformity.

It may, however, be thought that we deal only with generalities, we are quite ready to enter into details. The first preliminary step to the examination which we made was to plot upon the map the observing-hours at each station. It would cost £10 or £20 to put this map before our readers, we can, therefore, only select a few cases where apparently little difficulty could arise in advancing towards the period when, as we said in the review, "we shall see the nineteen varieties reduced to two or three."

The following are the facts of the case, as to the number of stations employing each combination of hours—

Stations.	Hours.	Stations.	Hours.	Stations.	Hours.
1 ...	5 12 7	1 ...	6 2 8	4 ...	7 2 8
2 ...	5 12 8	18 ...	6 2 9	58 ...	7 2 9
1 ...	6 12 6	28 ...	6 2 10	11 ...	7 2 10
1 ...	6 12 7	1 ...	$6\frac{3}{4}$ $1\frac{1}{2}$ 8	1 ...	8 1 9
1 ...	6 12 8	1 ...	7 12 7	1 ...	8 2 8
1 ...	6 12 9	1 ...	7 12 10	1 ...	8 2 10
1 ...	6 1 8	5 ...	7 2 7	10 ...	not stated.

The large proportion (40 per cent.) of the Austrian observers adopting 7 a.m., 2 p.m., and 9 p.m. (hereinafter for brevity's sake we shall merely give the numerals) renders it evident that of the above-mentioned "two or three" 7, 2, 9, must be one. There is another argument for the combination 7, 2, 9, in the fact of 7 a.m. being the time of the Austrian (and also other nations') observations for weather telegraphy, consequently all stations observing at 7, 2, 9 would be available for International or chartographic meteorology on special occasions when the ordinary telegraphic reports require supplementing.

Assuming then that 7, 2, 9 be adopted, and rejecting from consideration the ten stations at which the hours are not stated, the table shows that there are already 58 stations observing at those hours, and 29 other stations at which the change of only one hour at one of their three observation-hours would bring them also into uniformity, viz., 18 to change from 6, 2, 9, to 7, 2, 9, and 11 to change from 7, 2, 10, to 7, 2, 9. To these might surely be added the 28 observing at 6, 2, 10, which by shortening their day an hour at each end would swell the band of 7, 2, 9, to 115 out 139; the remaining 24 stations will be seen by the table to have scarcely anything in common, and, therefore, as we said in the Review we think that they should be printed separately.

It is scarcely for us to discuss the changes desirable at individual stations, but among the most obvious we may mention Lesina from 7, 2, 10, to 7, 2, 9; St. Paul, in Kärnthen, from 6, 2, 9, to 7, 2, 9; Bludenz, from 6, 2, 10, to 6, 2, 9, or better still to 7, 2, 9, if the adjacent stations could also be induced to adopt the latter.

THE LAW OF STORMS.

To the Editor of the Meteorological Magazine.

SIR,—The Essay of M. Faye on "The Law of Storms" scarcely merits criticism, but as its publication in the Annuaire of the Bureau des Longitudes, and that of a lengthy abstract in the pages of such a journal as "Nature," may seem to indicate a retrograde tendency in a branch of science which is highly progressive, it is worth while to call attention to one or two points contained in it.

I.—The analogy between waterspouts and cyclones is sufficiently antiquated, and so much stress has been laid on it (unfortunately, as I think,) by Milne Home, Reye, and other "theorists of aspiration," that these cannot complain if it is now employed by an opponent. But if that analogy were more complete than it is, it would be none the less unscientific to argue *ab ignoto ad notum*, from phenomena on a small scale which are not capable of minute investigation, to others on a large, the conditions of which easily admit of almost complete examination. In a cyclonic storm the changes of pressure, temperature, the elastic force of vapour, the value of gradients, the direction and force of surface winds, and of upper-currents, their inclination to and from the isobars, &c., are readily observed and analysed. But we have no "intelligent demons" resident in the circumference and interior of a waterspout, and provided with suitable instruments for the registration of the phenomena supposed to be analogous.

II.—The incurvation of surface-winds towards centres of barometric depression, and their efflux from areas of elevation is *a most certain fact*, which any one who has constructed, or even inspected, faithful daily weather charts for one month, may be safely challenged to deny.

III.—The fact that, at a considerable elevation from the earth's surface, the currents commonly make such an angle with the surface-wind as to flow somewhat out of the areas of depression is perfectly well known to every observer who has for a very limited period compared the direction of the cloud-drift with that of the surface-wind.

IV.—The fact that the direction taken by a depression is *not* dependent upon that of its upper-currents, but that on the contrary the disposition of the upper-currents *is* dependent on the position of neighbouring depressions is also familiar to every cirrus observer.

V.—The influence on the barometer (an instrument, by the way, which is dismissed with much brevity by M. Faye, naturally enough) of the dynamical as distinct from the statical conditions of atmospheric pressure, forms a subject which certainly needs, and which is receiving, investigation. But it is practically necessary, on M. Faye's theory, to regard the barometer as influenced by the dynamical condition *alone*, a conception which will scarcely be entertained by any meteorologist of the present day.

That the theorist of the study—a study whose shelves would appear to contain hardly any meteorological work published since 1850—

should ignore the labours, both observational and theoretical, of investigators such as Buchan, Mohn, Meldrum, and Hildebrandsson is, perhaps, natural; but that he should dismiss their results as those of mere theorists, the "victims of hypothesis and old prejudice," as exploded dogmas—exploded by the *ipse dixit* of M. Faye—is surprising in anything claiming to be a scientific treatise.

All honour to our earlier cyclonologists, Redfield and Reid, who would be the first to acknowledge the importance of those modifications which subsequent research has shown to be necessary to their theories. But another retrogression similar to M. Faye's will easily carry us back to the grotto of Æolus, the earliest enunciator, so far as I am aware, of the "Law of Storms."—Yours faithfully,

W. CLEMENT LEY.

Lutterworth, Dec. 7th, 1875.

THE WINTER OF 1875-6.

To the Editor of the Meteorological Magazine.

SIR,—In your magazine for April, 1874, I stated a law showing that "when the total (mean) rainfall of April, May, July, and August, at about 40 or 50 stations, is less than 10·60 inches, but above 8·60 inches, the following winter is partly very severe." This year the total (mean) rainfall of the aforesaid four months was 10·80 inches, which is a little above the average I gave. The longer average of 30 years, however, is 11·2 inches. Compared with this, the four months referred to (of this year) were drier than usual, and as February, March, and April last appear to have been drier over the whole country than any other corresponding period on record, the coming winter should be a very severe one.—Yours obediently,

GEORGE D. BRUMHAM.

Barnsbury, Nov. 29th, 1875.

MOVEMENTS OF CIRRUS.

To the Editor of the Meteorological Magazine.

SIR,—I have a collection of 2,480 observations of the movements of Cirrus, made in the last ten years in the counties of Hereford, Derby and Leicester. The directions were as follows :—

N.	101.	S.	104.
N.N.W.	231.	S.S.E.	64.
N.W.	282.	S.E.	52.
W.N.W.	327.	E.S.E.	25.
W.	361.	E.	22.
W.S.W.	356.	E.N.E.	15.
S.W.	264.	N.E.	26.
S.S.W.	185.	N.N.E.	65.

There is one important particular in which the above figures do not speak for themselves, but require to be supplemented by a modifying remark. I believe that the number of observed upper-currents from E. and N.E. points is unduly low, as compared with the unobserved. I am led to this conclusion simply from the following fact:—Periods of many days' duration every now and then occur in which Cirrus is *very rarely visible;* and when in the course of these periods an observation can be taken, the upper-current is very frequently found to be from an easterly point. As an instance, I may mention a period which has just reached its conclusion—that extending from November 18th to the 10th of the present month. Of these 23 days Cirri were visible on six only, or a little more than a third of what should be the average number. And on each of those six days the movement was from an easterly point. The paucity, it may be remarked, of observations in those periods is due, not so much to the frequently overcast state of the sky, as to the absence of Cirrus when the sky is not overcast.

It is worthy of note that of the N. and N.W. upper-currents a very large proportion have been contributed by the early spring months, that the South-westerlies were most common in mid-winter and mid-summer, and that the Southerlies were more prevalent in the beginning of autumn, than at any other time. The years examined differed, however, a good deal in these respects. There was also considerable difference in the mean flow of the upper-currents in the different years, though hardly so much as I should have anticipated. Of the series, 1868 and 1875 were perhaps the most remarkable, from the unusual frequency of northerly upper-currents in the former, and of south-easterly in the latter, in the summer months. The maximum frequency of southerlies and south-westerlies occurred in 1872.

Are such conclusions as may be drawn from the above figures likely to be applicable to other districts besides that in which the observations were taken? I have not sufficent data from which to answer this question fully. But I may say that, judging from a very limited number of observations, the mean directions of upper-currents over France and Germany do not seem to differ much from our own; but that in Scandinavia the further we proceed to the north the more do upper-currents from northerly points appear to predominate. Dr. Hildebrandsson has called my attention to the frequency of northerly upper-currents over the north of the Gulf of Bothnia, and out of 183 observations taken by Dr. Waldenström at Umea, in the first ten months of this year, I find that Cirrus travelled in 133 instances from N.E., N., or N.W. points.—I am, Sir, yours truly,

W. CLEMENT LEY.

Ashby Parva, Lutterworth, Dec. 14th, 1875.

BOOKS RECEIVED.

AUSTRIA.

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LEICESTER. Third Report of the Museum Committee to the Town Council. 8vo. 1875.

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HINRICHS, DR. GUSTAVUS. Preliminary Note on the Iowa County Meteorites. Single sheet 4to.
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SUPPLEMENTARY TABLE OF RAINFALL IN NOV., 1875.

[For the Counties, Divisions, Latitudes, and Longitudes of these Stations, see Met. Mag., Vol. X., p. 28.]

Station.	Total Rain.	Station.	Total Rain.
	in.		in.
Acol	5·38	Gainford	5·79
Hailsham	5·71	Shap	3·84
Strathfield Turgiss	3·41	Llanfrechfa	8·90
Addington Manor	4·32	Castle Malgwyn	6·28
Oxford	3·80	Heyope	...
Cambridge	3·66	Melrose	4·35
Sheering	3·78	Cessnock, Glasgow	4·43
Ipswich	4·65	Gruinart	5·40
Diss	5·06	Keith	4·37
Swaffham	5·55	Strathconan	4·33
Compton Bassett	4·02	Springfield, Tain	2·95
Hessary Tor, Dartmoor	9·26	Skibbereen	4·88
Teignmouth	5·81	Fermoy	5·48
Torrington	8·21	Kilrush	2·93
Trevarrick, St. Austell	7·96	Kilkenny	2·52
Taunton	4·64	Kilsallaghan	5·15
Cheadle	4·17	Twyford, Athlone	3·75
Ashby de la Zouch	4·23	Ballinasloe	...
Coston, Melton Mowbray	4·23	Kylemore	5·99
Bucknall	5·08	Bangor	5·11
Mansfield	3·99	Carrick on Shannon	4·30
Walton, Liverpool	3·12	Warrenpoint	5·87
Broughton-in-Furness	7·41	Bushmills	4·74
Stanley, Wakefield	3·48		

NOVEMBER, 1875.

Div.		STATIONS. [The Roman numerals denote the division of the Annual Tables to which each station belongs.]	RAINFALL. Total Fall.	Difference from average 1860–5	Greatest Fall in 24 hours. Dpth	Date	Days on which .01 or more fell.	TEMPERATURE. Max. Deg.	Max. Date.	Min. Deg.	Min. Date.	No. of Nights below 32° In shade	On grass
			inches	inches.	in.								
I.	ENGLAND.	Camden Town	3·36	+ ·95	·67	10	20	58·8	18	25·6	27†	3	11
II.		Maidstone (Linton Park)	4·39	+ 1·20	·87	8	23	58·0	18	28·0	26‡	2	...
,,		Selborne (The Wakes)	4·73	+ 1·19	·73	10	17	57·0	4	25·0	27	6	12
III.		Hitchen	4·16	+ 2·02	·81	10	21	54·0	4	24·0	30	10	...
,,		Banbury	4·84	+ 2·64	1·12	13	23	56·0	18	26·0	26	10	..
IV.		Bury St. Edmunds (Culford)	5·26	+ 2·87	·89	10	19	58·0	18	25·0	25	7	17
V.		Bridport	4·75	+ 1·59	·95	7	16	63·0	4	23·0	27	10	...
,,		Barnstaple	7·15	+ 3·01	1·47	13	20	64·0	4	26·0	27	..	...
,,		Bodmin	7·12	+ 2·14	1·07	12	19	60·0	3	26·0	27	5	12
VI.		Cirencester	5·04	+ 2·25	1·12	13	14	...	...	...	...	...	...
,,		Shifnal (Haughton Hall)	3·56	+ 1·99	·64	9	16	57·0	18	26·0	9	10	17
,,		Tenbury (Orleton)	4·04	+ 1·57	·76	13	24	62·0	4	27·0	9	5	14
VII.		Leicester (Belmont Villas)	3·61	+ 1·43	·80	13	23	59·2	18	29·8	9	4	..
,,		Boston	4·90	+ 2·76	·93	13	25	57·0	4, 18	30·0	9,26	5	...
,,		Grimsby (Killingholme)	5·82	...	·76	13	24	56·0	4*	31·0	9‖	4	...
VIII.		Manchester	...	...	...	...	...	...	...	...	...	...	...
IX.		York	...	...	...	...	..	...	...	...	..	..	..
,,		Skipton (Arncliffe)	7·66	+ 1·21	1·80	13	24	50·0	17	24·0	13	16	...
X.		North Shields	5·81	+ 3·11	1·53	13	23	56·6	5	30·3	9	4	13
,,		Borrowdale (Seathwaite)	12·10	— 4·57	2·15	18	14	...	...	...	...	...	...
XI.	WALES.	Cardiff (Ely)	8·24	+ 4·00	1·67	13	17	...	...	...	...	...	...
,,		Haverfordwest	7·61	+ 1·94	1·17	13	20	58·0	4	23·0	26	5	12
,,		Rhayader (Cefnfaes)	...	...	..	...	...	...	...	...	...	...	...
,,		Llandudno	4·25	+ 1·09	1·08	13	16	61·1	3	32·8	27	...	...
XII.	SCOTLAND.	Dumfries (Crichton Asylum)	3·94	+ ·68	·98	2	11	58·4	5	23·8	10	10	18
,,		Hawick (Silverbut Hall)	3·71	...	·85	13	21	...	...	...	...	...	...
XIV.		Kilmarnock (Annanhill)	3·96	...	1·04	2	16	58·4	4	22·7	11	16	17
XV.		Castle Toward	...	...	...	...	...	...	...	...	...	...	..
XVI.		Leven (Nookton)	4·51	+ 1·47	·56	13	21	57·0	4,5	21·0	11	11	20
,,		Stirling (Deanston)	...	...	...	...	...	..	...	...	...	...	...
,,		Grandtully	3·15	...	·50	13	11	...	...	..	...	..	...
XVII.		Braemar	4·07	+ 1·25	·86	13	20	53·8	4	10·0	10	19	24
,,		Aberdeen	3·95	...	·46	7	25	59·2	4	22·1	11	7	19
XVIII		Loch Broom	4·77	...	·56	15	15	...	...	...	...	...	...
,,		Portree	7·15	— 3·33	1·71	18	18	...	...	...	...	...	...
,,		Inverness (Culloden)	3·09	+ ·50	1·08	8	17	57·3	3	23·1	27	14	24
XIX.		Helmsdale	4·68	...	·73	6	24	...	...	...	...	...	...
,,		Sandwick	4·05	+ ·05	·92	18	21	52·9	4	28·0	28	7	18
XX.	IRELAND.	Caherciveen Darrynane Abbey	4·37	...	·78	13	15	...	...	...	...	...	...
,,		Cork	4·21	...	1·00	3	15	...	...	...	...	...	...
,,		Waterford	4·44	+ ·49	·80	2	20	61·0	5	29·0	27	6	...
,,		Killaloe	4·42	— ·47	·78	13	15	60·0	2	26·5	22	...	...
XXI.		Portarlington	3·11	— ·81	·97	14	22	59·0	2	27·0	26	12	...
,,		Monkstown, Dublin	3·98	+ 1·09	1·09	13	18	...	...	...	...	...	...
XXII.		Galway	2·84	...	·82	1	14	59·0	2,5	25·0	27	10	...
,,		Ballyshannon	3·66	...	·55	13	15	...	..	...	...	...	...
XXIII		Waringstown	3·55	...	1·19	13	20	61·0	3	23·0	8	17	21
,,		Edenfel (Omagh)	4·10	...	1·05	13	15	57·0	2	21·0	10	19	...

* And 17 & 18. † 30. ‡ 27. ‖ 10, 26 & 27.

+Shews that the fall was above the average; —that it was below it.

METEOROLOGICAL NOTES ON NOVEMBER.

ABBREVIATIONS.—Bar. for Barometer; Ther. for Thermometer; Max. for Maximum; Min. for Minimum; T for Thunder; L for Lightning; TS for Thunderstorm; R for Rain; H for Hail; S for Snow.

ENGLAND.

LINTON.—First twenty days mild, dull and wet, with high winds on the 6th and 14th; afterwards it was much colder, the last week wintry, with S every day, and the ground slightly covered all the time. The winds very changeable in the early part of the month, but settled into the N. towards the end; the nights often very dark. Altogether it may be pronounced a wet month, and early beginning of winter.

SELBORNE.—An unusually wet November; autumn wheat sowing seriously interfered with. Prevailing winds more or less S. or S.W. to the 14th, then W. for a few days, and the last ten days N. and N.E.. Bar. remarkably low throughout; ther. at the freezing point on the 1st, the first time since April 26th; [max temp. of the 30th only 31°.

BANBURY.—Floods on 7th, on 11th, and still greater on the 14th, when the water was 9 in. deep over the rail at the Great Western Railway Station, and a portion of the permanent way was much injured; on that day it was very dark at 2 p.m., and the wind high in the latter part of the day.

CULFORD.—Bar. very low about the 9th, but rose very suddenly on the 14th; high wind on 19th; S on 20th and 27th. Easterly winds prevailed on 16 days, and westerly on the remaining 14. The month remarkably free from fogs. Mean temp. 40°·9.

BRIDPORT.—Very high tide. Heavy gale of wind, and floods higher than known for years on the 6th.

HAUGHTON HALL.—This has been a wet, cold, unpleasant month, for when it did not rain, which it did daily with few exceptions till the 19th, keeping up thereby the vast saturation of October, the cold winds from N.W., N., and N.E., which accompanied the R, and followed it to the close, rendered the temp. low and trying; but there were no fogs. Frosty nights began on the 8th, and continued with a few exceptions (11th, 14th, 18th, 19th, 23rd and 24th) to the end. On the 9th the R and S amounted to ·64 in. The steadiness of the bar., from 20th to 30th inclusive, was remarkable—the range being then only from 29·64 to 29·87. Redwings first seen on 3rd; large flocks of wild geese flying from E. to W. on 25th.

ORLETON.—Very cloudy and gloomy, with a temp. generally high, and heavy falls of R till the 19th; on the 10th and 14th great floods on the river Teme. Bar. generally low till the 14th, when, at 10 a.m., it stood at 28·70, and at 9 p.m. it had risen to 29·70, an increase of 1 in. in 11 hours. On the 19th the wind became very violent, and changed to the N.W. and N. The remainder of the month very cloudy and cold, but dry. The mean temp. of the month was about half a degree above the average.

LEICESTER.—Another wet month, especially the first half. High floods on the 14th for a few hours. Mean temp. 41°·6; temp. very low during the last week, especially by day; 25·62 in. of R (nearly a year's average) have fallen since the 1st of June.

BOSTON.—The rainfall of this month (4·90 in.) is the highest on record here, the next being in 1852, when 4·32 in. fell; the fall for Sept., Oct., and Nov. of this year is 10·64 in., against an average of the preceding 20 years of 5·97 in.: this quantity was exceeded in 1852, when 11·05 in. fell. Notwithstanding this heavy fall the Fens have not suffered the severe damage experienced in other places. Owing to steam and pumps, some of the lowest land is the driest; and with the exception of a small area of low-lying land not drained by steam-power, and one or two districts where the protecting banks have given away, no damage beyond the delay in sowing the wheat has been done, although the Witham has been fuller than ever known before.

GRIMSBY.—Lunar halo on 7th and 12th. Very high tide in the Humber at night on 14th. Very wet month, and the latter part of it cold; scarcely a pleasant day from the beginning to the end. The ground thoroughly saturated, and causing apprehension with regard to the newly sown wheat.

ARNCLIFFE.—Wet, dark and cold. Rapid rise in bar., 28°·20 to 29°·83, on 15th.

NORTH SHIELDS.—L on 8th; lunar halos on 8th, 9th, 12th and 14th; high night temp. on 17th.

SEATHWAITE.—Three days on which the fall was 2 in. or more.

WALES.

HAVERFORDWEST.—The first three weeks incessant R, followed by a cold, dry, frosty period; and under the influence of the keen E. wind and the sharp frost the ground rapidly became admirably prepared for agricultural operations. Several heavy gales, and very great floods, characterized the month.

LLANDUDNO.—The beginning of the month very wet and damp; after the 18th a cold period, E. and N.E. winds, with a dull, leaden sky, and scarcely any sun. Lime divested of leaves on 2nd, chesnut on 5th, mountain-ash and sycamore on 9th, copper-beech on 13th, and hawthorn and wych-elm on the 18th. Hills covered with S from the 8th.

SCOTLAND.

DUMFRIES.—The first half of the month wet and blustering, but no violent gales or destructive floods; the latter half cold and dry, with moderate northerly winds and almost continuous frosts. Rainfall, though above the average, is 1·70 in. lower than November of last year. Mean temp. 40°, being 2° lower than last November.

HAWICK.—First S shower on the 7th; ground covered with S to the depth of 4 inches from the 23rd to the close. Hurricanes on 13th and 19th; winds easterly from 13th to 30th. The frost has not been severe during any night of the month.

ANNANHILL.—Aurora and L on evening of 9th; S on 9th, 25th, 26th, and 30th; gale, E.N.E., on 13th, velocity 56 miles an hour.

NOOKTON.—High wind at 7 p.m. on 13th.

BRAEMAR.—An unusually cold, frosty month. Potatoes and turnips, in consequence, to a good extent unsecured.

ABERBEEN.—A month of stormy, unsettled weather; winds from the N.E. and E., more frequent than the average; R above the average; bar. pressure, temp. and wind pressure below the average. L on 25th. Min. on grass 16°·7 on the 11th.

LOCHBROOM.—R on every day but the 9th to the 16th inclusive, thence to the end of the month the most intense frost ever remembered so early in the season, insomuch that an arm of the sea called the Big Loch was frozen over from side to side for miles for some days an inch thick, a circumstance never seen at this time of the year before.

PORTREE.—Heavy gale from the N. from 4 a.m. to 9 a.m. on 19th; S, H and sleet showers from 7th to 12th, and hard black frosts from 21st to the end of the month.

SANDWICK.—The first half of November was wet and boisterous, but the last nine or ten days were uncommonly fine, being dry, calm and frosty. I do not remember such a continuation of calm days as we had on the five succeeding the 21st; the anemograph marked only 12 miles on the 23rd, and 19 on the 24th. The most remarkable meteorological phenomena was the curious abnormal Iris on 29th, at 10.15 a.m., of which I enclose a sketch. [See p. 165.]

IRELAND.

DARRYNANE.—First fortnight wet and foggy, last ten days very dry and hard frost at night; gale on the night of 13–14th from W., with fearful squalls; many trees blown down and hay stacks upset. Fresh gale on 6th, and a moderate one on 28th.

BALLYSHANNON.—The first half of the month has been marked by heavy R, by which the river Erne was swollen to an unusual extent; the latter half has been free from R, and smart frost has occurred on every night. Ice on the lakes 1 in. thick; mountains covered with S.

WARINGSTOWN.—The dry weather and cold easterly wind in third week enabled the farmers to get on with wheat sowing, which had been hitherto impossible; a large breadth has been sown in the last ten days. This district has to a very great extent escaped the heavy rains, aud the fall has very little exceeded the average.

EDENFEL OMAGH.—Weather up to the 18th a continuance of the incessant wet which prevailed during October, but with a steadily decreasing temp. From the 18th to the end dry, cold and generally clear, with frost more or less every night.